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FOREST SERVICE

NATIONAL WETLAND RESEARCH PROGRAM

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ROCKY MTN. FOREST & RANGE
EXPERIMENT STATION

FOR FURTHER INFORMATION CONTACT:
DR. ANN M. BARTUSKA
WETLANDS SPECIALIST
FOREST ENVIRONMENT RESEARCH
USDA FOREST SERVICE
201 14TH STREET, S.W.
WASHINGTON, D.C. 20250

TELEPHONE: 202-205-1524

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INTRODUCTION

While the total acreage involved may be small when the entire landmass is considered, the importance and value of wetlands far exceeds their extent. Of the 191 million acres for which the Forest Service has management responsibility, approximately 12 million acres have been identified as wetlands and riparian areas. These wetland ecosystems are critical avifauna habitat, both for breeding and for waterfowl flyways. Wetland and riparian systems play a major role in flood control, in the improvement of water quality, and in food chain support. Additionally, wetland and riparian areas, especially in the western United States, provide habitat for numerous rare and endangered plants and animals. In the maintenance or enhancement of biological diversity, wetlands and riparian areas are an essential part of the landscape. Economically, timber production, fisheries, and recreation vie as primary users of forested wetlands.

In May 1991, the Chief of the Forest Service identified Wetlands as a National Problem Area for the FY 1993 budget; this decision has been carried into the FY 1994 budget deliberations. Identification of "Wetlands" as a priority program in the FS reflects the importance of wetlands as a major water issue in the minds of the general public, industry, and the legislators. Through workshops with Forest Service scientists and with external cooperators, the Program is currently being developed. This document will describe research that has been part of the Forest Service's ongoing efforts, and will identify the key program areas which will be highlighted in the future.

CURRENT PROGRAM

Forest Service Research is organized geographically into eight Stations, and while some research within each Station is specific to its region, much of the research has national implications. Some of the earliest research done by the Forest Service focused on watershed management with emphasis on waterflow and quality. Several of these experimental watersheds have been studied for over 50 years and are internationally recognized: Coweeta, H.J. Andrews, Hubbard Brook, Fernow. Research relevant to wetland issues has been part of Forest Service activities in many other locations. The following paragraphs will provide a thumbnail sketch of some important accomplishments related to wetlands research in six of the Stations.

Intermountain Station (ID, MT, NV, UT)

Research on riparian areas has been the emphasis of one of the research projects in Boise, Idaho, whose mission is to develop an improved understanding of riparian and stream habitats. The unit also is concerned with improving methods for habitat management, for conservation of resources, and for production of livestock, wildlife, and fish. More recently, an interdisciplinary team, comprised of fisheries biologists, hydrologist, soil chemist, botantist, and management specialists, will be focusing on the enhancement of salmonid fisheries habitat. Research has consistently examined the role of riparian habitats on the landscape as islands of diversity (including the abiotic characteristics of these habitats). For example, studies have determined that 59 percent of small land birds in western Montana use riparian habitats during the breeding season, while 53 percent of Idaho's neotropical migrant land birds use these areas for breeding habitat.

The same features of riparian areas that attract "wild" species, also make these systems useful for livestock. Research has described the degradation of many systems due to overuse, and has made significant progress in rehabilitating damaged ecosystems. Fundamental research on plant community succession following restoration is ongoing, as are basic phenological studies of important riparian species.

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North Central Station (IL, IN, IA, MI, MN, MO, WI)

The region is a complex ecosystem of uplands, wetlands, lakes, streams and, where recreation shares land-use with timber production. The Station has been studying the peatland ecosystems since the 1950's, with much of the work done on the Marcell Experimental Forest. Research has emphasized the understanding of hydrology and biogeochemistry. Recently that has meant a thorough analysis of the impact of acidic deposition on peatland chemistry. Efforts are continuing to examine methane production and CO_2 flux from northern peatland ecosystems.

In addition to fundamental studies on wetland processes, Station researchers are also examining the cumulative effects of alternative management systems. This research is coordinated with the forest engineering project, which is developing harvesting techniques and technology for use on unstable soils.

Pacific Northwest Station (AK, OR, WA)

Alaska, has many unique ecosystems, including 40 million acres of forested wetlands. Much of the research has emphasized the forested landscape of the southeastern panhandle, including some characterization of associated wet-muskegs and riparian areas. The most significant opportunity for wetlands research lies within the Copper River Delta (CRD). The CRD stretches 75 km along the south central coastline of the Gulf of Alaska and is rich in waterfowl and fish habitat. The dynamic nature and diversity of the ecosystem will serve as the basis for planned fundamental research on the structure and functions of complex delta systems.

In Oregon and Washington, research has concentrated on riparian habitat restoration and management, in association with other management activities.

Rocky Mountain Station (AZ, CO, KS, NE, NM, ND, SD, TX, WY)

Scientists in Tempe, Arizona, have led the research effort to understand the functioning of riparian areas in the southwestern United States. Initial focus was on animal (domestic and wild) interactions in these systems. Generally, research has emphasized the management of riparian areas to enhance, maintain, or restore vegetation and hydrologic conditions in these ecosystems. Research has resulted in management guidelines for use in the field as well as basic information on flora and fauna composition and distribution. Ongoing studies deal with the structure, function, and composition of these ecosystems and the interface with the aquatic system (fish and water). Studies are being done on channel dynamics and on water table controls on riparian vegetation. The impact of livestock grazing on riparian areas is a major emphasis area throughout the Rocky Mountain west, as evidenced by similar research in the Intermountain Station.

Southeastern Station (FL, GA, NC, SC, VA)

There has been a long history of research in wetland systems, focusing primarily on stand productivity in pocosins (Croatan NF) and bottomlands (Francis Marion NF/Santee Experimental Forest). To provide greater focus, the Center for Forested Wetlands was established in 1988, in association with Clemson University, at the Forestry Sciences Laboratory in Charleston, South Carolina. Emphasis has been on growth and productivity of wetland tree species under different management activities, with special attention being given to studies of soil chemistry and the role of flooding on plant physiology. Hurricane Hugo has provided a new opportunity to evaluate effects of catastrophic disturbance on the hydrology and biogeochemistry of forested systems, including wetlands. Efforts are increasing in the area of wetland restoration, both at the Santee and at the Savannah River Forest site.

The Station has recently initiated research to examine the use of buffer strips to protect forested wetlands from impacts due to upland silvicultural operations. This is an extension of the IMPAC (Intensive Management Practices) project's studies on nutrient and herbicide transport in subsurface systems in central Florida.

Southern Station (AL, AR, LA, MS, OK, TN, TX, PR)

Bottomland hardwood forestry research began at Stoneville, Mississippi, in 1937 and, while the specific problems have changed, the basic mission of the Laboratory, to study regeneration and management of southern hardwoods is current. Locations of concern include the Mississippi River Delta with associated swamplands, and other major and minor drainages in the central-South. Emphasis is increasing on natural regeneration methods for even and uneven-aged forests. Scientists at the lab are studying growth and yield, and insect and disease problems, as well as examining the role of these wetland systems at all stages of growth as wildlife habitat. Factors include habitat age or successional sere, size of area, species composition, structure, landscape context, and hydrology.

Other areas of research are engineering and economics. Just as in the North Central Station, the management of bottomland sites has necessitated the evaluation of harvesting methods, leading to systems for reducing site impacts on wetland forests. The Economics unit in New Orleans continuously monitors and analyzes Federal and State wetland regulatory laws as they relate to forest managment and forestry practices. Research has also been done on the economics of converting forested wetlands to crop production in the Lower Mississippi Alluvial Plain.

Both Southeastern and Southern Stations are explicitly indentifying wetland systems in their Forest Inventory and Analysis (FIA) data base. The Southeastern Station has taken a look at additional variables which could be used to better characterize forested wetlands.

FUTURE PROGRAM

Scientists and managers from the eight research Stations met on August 20-21, 1991, to identify critical research areas for the Forest Service's - Wetlands National Problem Area. The discussion acknowledged that a significant amount of research on wetland ecosystems or related to wetland and riparian issues has been done by Forest Service scientists. The "new" program must build on what has been accomplished, but we also must target research to deal with the new and emerging issues in wetland protection, restoration, and management. We also must recognize that other agencies, especially Fish and Wildlife Service, Environmental Protection Agency, and the Army Corps of Engineers, have important research programs already underway. Forest Service Research must both build on this existing research and be complementary to these efforts.

The following section will identify Program Bounds, Program Elements, and Criteria for Prioritization of research.

Program Bounds

The purpose of this section is to provide some guidelines regarding what types of ecosystems would be studied within the Forest Service program. The recent controversy regarding the 1991 Revised Federal Manual for Delineating Wetlands raises concerns about how wetlands should be defined for research purposes. The geographic and physiographic positioning of wetlands also must be considered, particularly with regard to the extent of riparian studies within a Wetlands program. Some guidance is provided below; however, it is acknowledged that the scope or emphasis may change over time as technical and political issues change.

1. The primary driver of wetlands issues comes from the South and the urbanizing East--the interest and concern that is focused on management practices as they affect wildlife and waterfowl habitat or timber harvesting. However, there are other geographic areas that are just as important but which have not attracted National interest. Local and regional concerns regarding developmental pressures, no-net-loss and mitigation, and wetland restoration are widespread. It is important and necessary to have a way of addressing these issues.

2. Forest Service Research needs to identify scientific gaps in our wetlands understanding, and to tailor our program accordingly; the research emphasis in each region of the country should reflect the local issues. In the East, this means listening to the multiple-use concerns of private landowners. In parts of the West, our issue may be streamside wetland restoration from grazing or restoration of the marshes along the

Pacific Coast. In coastal landscapes, estuarine environments have been incorporated into some Forest Service research efforts, especially those dealing with anadromous fisheries.

3. Jurisdictional wetlands should be considered but research should not be limited to these systems as regulatory definitions will continue to change. Utilization of the definition will limit the extent of riparian areas and other valuable systems that would be included in a Wetlands program. Forest Service Research should use the wetlands definition as stated in the Federal Delineation Manual (1989) which reads as follows:

> Wetlands are defined, under Section 404 of the Clean Water Act, as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

4. Geographically, the areas of greatest interest are: southern bottomland hardwoods and southeastern coastal fringe wetlands, peatlands in the northcentral and boreal regions, and riparian wetland habitats in the west. The proposed research program will emphasize these areas, but will not exclude other locations identified as high priority by specific Research Stations.

Program Elements

The program to be initiated in FY 1993 is comprised of five broad categories of research encompassing a range of subelements. In the following presentation, questions are identified for each category, as well as several key-words which further describe the scope. The elements identified should be considered over a 10-year timeframe; therefore, not every element will be studied in FY 1993. Similarly, some elements are of interest or an issue only in particular regions of the United States; therefore, not every Station will pursue all elements. Tables 1 and 2 indicate the approximate level of effort in each Station for the different elements.

Cooperation with other Agencies

The research elements which are described will overlap with the research emphasis of other agencies. This Program Plan has been developed with input from the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Geological Survey, and the Environmental Protection Agency. In identifying the elements, an effort was made to recognize those areas of research for which the Forest Service is uniquely qualified and to complement ongoing research efforts. Progress has already been made in the southern United States through the Consortium for Research on Southern Forest Wetlands. A regionwide joint study to assess the functions of forested wetlands has been developed by the Southeastern and Southern Experiment Stations, in cooperation with the National Wetlands Research Center (Fish and Wildlife Service). The participation of Forest Service Research on various interagency coordinating committees dealing with wetlands is an important mechanism to ensure continued cooperation.

ECOSYSTEM PROCESSES

How do wetlands function?

How do natural and human-induced disturbance alter these functions?

KEY WORDS: Dynamic models, growth and yield, bottomland hardwood stand development, inventory, ecophysiological processes, insects and disease dynamics (hardwood decline/defoliators), greentree reservoir, water supply, dewatering, stand degradation.

1. **Predict stand/community structure and compositional changes, integrating ecophysiological processes, through the development of ecosystem models.** Modeling activities will range from whole system conceptual models to more detailed submodels; however, the intent is to be able to evaluate wetland ecosystem changes driven by key processes or management activities. Also included would be models that describe short-term (e.g., within a rotation) responses to predict event effects on the stand.

   The support of research studies to strengthen model development is considered within this element. Research may include above- and below-ground competitive processes as they affect species composition along nutrient and hydrologic gradients. For example, data are being accumulated on how changing water tables and water chemistry affect plant physiology or competition, and how that in turn would change the plant community. Communities of special interest are: bottomland hardwoods, cypress-gum swamps, pocosins, riparian areas in coastal redwood sites, peatlands, and northern boreal forests.

2. **Understanding the hydrologic regime of wetland systems, including patterns of temporal heterogeneity.** Variables of interest include timing, duration, and seasonality of water flux, and the control on successional structure. Linkages should be made to plant physiological processes, including transpiration and net primary production.

3. **Interrelationships of water quality and quantity on wetland "health."** Health refers to structure, species composition and productivity of the wetland ecosystem. Identify reference wetlands (undisturbed and typical) for use in evaluating funtions. *Inventory* and *monitoring* are key components of this research element. Water quantity and quality also are influenced by streamside zone characteristics and functions.

4. **Understanding natural patterns of disturbance as part of the baseline characterization.** This effort should consider impacts on wetland structure and function. A management question would consider how wetland health is affected by upland inputs.

5. **Influence of herbivory on structure and function of wetland ecosystems.** Included here is a consideration of all forms of herbivory, from defoliating insects to wildlife and livestock. Some emphasis will be placed on successional development and the changing impact on wildlife habitat.

6. **Habitat in relation to faunal communities; what are the requirements for supporting a viable population?** Consideration should be given to describing the faunal component of wetland habitats and evaluating impacts of habitat management. For example, in greentree reservoirs where annual flooding is resulting in oak declines, will the reduction in mast alter the duck population? A consideration can also be given to the effect of operational streamside management zones (SMZ) on faunal communities, including SMZ width.

RESTORATION AND REHABILITATION

To what degree can the desired functions be restored and what degree of difficulty is associated with their restoration?

What techniques are available to restore desired functions? What is the measure of success?

KEY WORDS: Degraded or dysfunctional sites, CRP, regeneration, structural, functional, short-term vs. long-term, natural recovery, enhancement.

1. **Determine the restoration potential of degraded or lost wetland systems through hydrologic manipulation, stream channelization, and revegetation.** Systems of concern for primary restoration include old fields, southwestern grassland cienegas, woody draws, and sites disturbed by thermal pollution or mining.

2. **Restore the productive capacity of wetland forests by "improving" the species complement.** This element refers to sites that presently are wetlands but with a species composition that is suboptimal (for example, bottomland sites in Mississippi Delta that were high-graded, leaving poorer quality species and reduced biodiversity). Many cut-over or mismanaged areas are not meeting their full potential as a functioning wetland. Additionally thousands of acres in the Delta region alone are being revegetated through the CRP program, often without full recognition of wetlands site characteristics. Research would include an understanding of the sustainability and productivity of the systems in terms of hydrology and vegetation.

3. **Develop regeneration methods for wetland systems.** Wetland ecosystems have many unique plant species where little or nothing is known about their reproductive or regenerative potential (e.g., filter strip species and Atlantic white cedar). Research will be needed to determine if regeneration can occur naturally or if some manipulation is required. For example, since seed or vegetative material is available, many high-mountain meadows will revegetate naturally if the disturbance factor is removed.

4. **Identification of "keystone" species that can influence the success or failure of restoration or creation.** Studies should include how these species function through wetland succession. Species such as white-tailed deer can devastate attempts to restore an ecosystem to Atlantic or Northern white cedar. Some species may indicate that the system is functioning as it should.

5. **Evaluation of mitigation and restoration success.** Consideration should be given to both the biology and hydrology, through monitoring, and the policy needs. Included in this element is research which can describe when a wetland is fully restored. Baseline information to determine the functions and processes consistant with "fully restored" is necessary. The cost-benefit analysis of restoration also is of high priority, that is, when does the incremental cost of further restoration exceed the biological or sociological benefit?

MANAGEMENT OF THE WETLAND RESOURCE

What are the impacts of current management practices on wetland functions and values?

Are there alternative practices?

KEY WORDS: Long-term management philosophy, BMP's, forested wetlands, riparian areas, grazing (livestock and big-game), anadromous fish, pests.

1. **Influence of livestock grazing and domestic foraging on patterns of vertebrate abundance in riparian wetlands.** Research would include considerations of plant and animal diversity. Regionally specific issues include big-game species (elk, sheep) in the West, feral pigs in South, and native species in Northcentral region.

2. **Effects of alternative management practices on wetland ecosystems.** A major question is what practices can be used to increase or maintain productivity? Wildlife, fisheries, timber, and recreation are all important endpoints of alternative management.

3. **Management of habitats to maintain biological diversity.** Wetland ecosystems are critical habitats for migratory birds, including neotropical species. In addition, riparian and other wetlands, such as greentree reservoirs, are important refugia for threatened, endangered, and sensitive species.

4. **Establish guidelines for management decisions to control insect or disease impacts on wetland community structure.** The fruittree leaf roller on baldcypress and the willow borer in the West are pests which significantly alter wetland community structure, and therefore, impact management success.

5. **Develop low impact harvesting and transportation methods for use in wetland ecosystems.** Some methods (e.g., chunk roads) are already used in fragile environments; however, increased demand by the public and by land managers for appropriate technology makes the integration of this type of research essential. Consideration should also be given to the fate of pesticides and herbicides in wetlands, either when used in the wetland system or in the surrounding landscape.

6. **Develop the information necessary for Best Management Practices (BMP's) in land management operations, and evaluate their implementation.** Issues of particular concern are drainage operations, harvesting impacts, road building, mono-species regeneration, and current engineering methods.

7. **Evaluate the impact of public use (e.g. recreation), developmental pressures, including urbanization, on wetland functions.** Uncertainties exist in whether the integrity of wetlands can be maintained at the urban interface. Of interest in several parts of the country is the use of forested wetlands on or near National Forests as a disposal site for sewage and waste water; impacts on the wetland functions are not understood.

SOCIOECONOMIC VALUES OF WETLANDS

Can an economic value be ascribed to both commodity and noncommodity functions?

What are society's expectations regarding wetland functions?

KEY WORDS: Costs of protection, legal research, timber supply impacts, market vs. non-market (cultural) values, diffuse recreation, valuation determines management strategies.

1. **Valuation of the different functions or components of wetlands.** Efforts should identify the individual components (e.g., recreation, wildlife, timber, spiritual values) and for whom are they important. This valuation is not limited to assigning a dollar value, but is essential to make informed management decisions.

2. **Determine impacts of changing wetland regulations on timber supply.** Landowners are thought to be changing management practices, and therefore harvesting patterns, due to regulatory restrictions. This trend has not been brought into supply analyses (e.g., Southwide Resource Analysis).

3. **Cost-benefit and distribution of wetlands protection and management.** The intent is to better determine "who gains and who pays," although this does not necessarily mean that a dollar-value is applied.

4. **Evaluate the cost of implementing BMP's.** Landowners and managers need the tools to be able to evaluate available BMP's; this must include an assessment of the financial cost, whether the management objective is recreational, timber, or water quality protection.

5. **Analysis of legislation or regulation for impacts on land management decisions.** Are public or private landowners changing their practices? This issue is especially critical as the various States draft their own legislation, as the Clean Water Act is up for reauthorization, and as the Federal Government determines which Bill(s) to support.

LANDSCAPE-SCALE LINKAGES

What is the role of wetlands as an interface between uplands and water?

How important are wetlands as a feature on the landscape?

KEY WORDS: large temporal and spatial scales, biological diversity, temporary refugia for species, wildlife-livestock interactions, qualitative changes of habitat and wildlife, cumulative effects, filter strips and land-use, estuarine environments and anadromous fisheries.

1. **Effects of land-use patterns on wetland occurrence and functions.** A better understanding of the role of wetlands as "sinks" for different landscape features, such as chemicals or even wildlife. Important in this element is a consideration of the wetland/agriculture or wetland/urban interface.

2. **Influence of landscape characteristics on the suitability of wetlands for wildlife.** Characteristics would include, but are not limited to, topography and connectedness.

3. **Influence of landscape characteristics on hydrology and water quality.**

4. **Evaluation of the contribution of wetlands to the biological diversity across the landscape.**

5. **Role of wetlands as interface between upland and water systems.** On a landscape scale, this effort would include the position of riparian wetlands as buffer strips and their mitigating effect on nonpoint pollution. This element can be extended to consider the position of estuarine systems as an interface between upland and marine environments.

Criteria for Prioritization

Priority setting must be done at two levels, the Washington Office (WO) and the Stations. At the Station level, local concerns must be matched against operating funds and the scientific capability of staff and cooperators. WO prioritization must recognize the often conflicting needs of different regions. In making these decisions, the following criteria should be considered.

1. Management/Research Needs--NF's; public and private land managers, RPA, Strategic Plans

2. Science Issues--knowledge gaps; scientific validity

3. Operational Capabilities--current research capabilities; time to completion; probability of success

4. Politics/Policy Issues--includes public benefits

5. Cost--budget limitations; marginal costs vs. marginal benefits

6. Inherent Resource Value

7. Coordination/Cooperation with other Programs--within Forest Service and externally

Table 1. Program Elements for Emphasis by Station - FY 1993

		INT	NC	NE	PNW	PSW	RM	SE	SO
Ecoysystem Processes	1.							**	**
	2.		*				*	*	
	3.		*					*	
	4.						*	*	*
	5.	*					*		**
	6.				**				*
Restoration									
	1.						*		*
	2.							*	*
	3.	*						*	*
	4.								
	5.							**	*
Management	1.	*				*	*		
	2.				*	*	*	*	*
	3.	*	*			*		*	*
	4.								*
	5.		*				*		*
	6.		*			*		**	**
	7.								
Socio-economic Values	1.							*	*
	2.							*	
	3.							*	
	4.							*	
	5.							*	
Landscape Linkages	1.						*	*	*
	2.						**		*
	3.		*					*	
	4.								*
	5.		*		**			**	

Asterisk refers to number of Research Work Unit's participating in research and is an indicator of level of effort in each Station.

Table 2. Program Elements for Emphasis by Station - FY 1994-1999

		INT	NC	NE	PNW	PSW	RM	SE	SO
Ecoysystem Processes	1.	*	***					**	***
	2.		*			**	**	*	
	3.		*			***	*	*	
	4.		*			****	*	*	**
	5.	*	**			*	**		***
	6.		*	*	**	**		*	*
Restoration									
	1.	*					**	*	*
	2.					*		*	*
	3.	*				*	*	*	*
	4.	*	**						
	5.		*			*	**	*	*
Management	1.	*				*	**		
	2.		****		*	*		*	**
	3.	*	***			***	**	**	**
	4.		**						*
	5.		*						*
	6.		****			*		*	**
	7.	*	*			*		*	**
Socio-economic Values	1.		***				*	*	*
	2.		*					*	*
	3.	*	*					*	*
	4.	*	*					*	**
	5.	*						*	*
Landscape Linkages	1.		**				*		**
	2.		**					*	**
	3.		*			**	**	**	
	4.		*					*	*
	5.		***		**		***	**	*

Asterisk refers to number of Research Work Units participating in research and is an indicator of level of effort at each Station.